Notes on the Biology of California Scorpions [1]

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Two distinctively different types of scorpions exist. They differ morphologically, have unlike habitats and are dissimilar in the type and celerity of their movements. Examples of both types are found in the San Diego area.

One group is characterized by long legs, a slender body and a large thick cauda which terminates in a large telson. The pectines are well developed with many teeth, and the chelae have a long slender tarsus and tibia. These scorpions are of the errant type and are suited to actively pursuing prey, running to escape enemies, and hiding under debris. *Vejovis sylvestrii* is an example of this type. It is found in the San Diego area from Del Mar on the coast to Alpine in the Cuyamaca Mountains.

Anuroctonus phaeodactylus, an example of the second type, is an obligate burrower. It has shorter legs than errant forms, a stouter body and a shorter and more slender cauda which terminates in a reduced telson. The pectines are shorter and have fewer teeth, and the chelae are broad with a short, sturdy tarsus and tibia. During the day this scorpion remains in a burrow which it has dug. It ambushes prey from the burrow mouth during the night and retreats into its shelter when startled or threatened. Like *V. sylvestrii* specimens of *A. phaeodactylus* are widespread in the San Diego area.

The two groups differ in the speed of their movements. Errant types are noticeably more agile and quicker than burrowers. *V. sylvestrii* is a swift runner with rapid stinging reflexes. *A. phaeodactylus* is slower and relies on its pincers rather than its sting, for attack or defense.

The scorpions differ also in the movements of their pectines. *V. sylvestrii* uses its pectines while walking and when halted. It will brush over the substratum repeatedly with all the teeth of its combs. *A. phaeodactylus* uses its pectines only when walking, and touches the ground with its distal pectine teeth.

Although both scorpions will climb rough vertical surfaces, *V. sylvestrii* may remain several feet above the ground, but *A. phaeodactylus* never settles on a vertical plane.

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Eating Behavior

Neither errant nor burrowing scorpions show a definite pattern of eating. In the laboratory three specimens of *A. phaeodactylus* refused to eat for 90 days, although food was available. Other specimens of *A. phaeodactylus*, *V. sylvestrii* and *Uroctonus mordax* (a burrower from Oregon) have taken food in intervals as short as two days and as long as twenty-four days.

The scorpions were fed primarily on meal worms but also ate cockroaches, spiders, beetles, and ants. They did not eat sowbugs, dead insects, insect eggs or bits of raw meat offered them. Both types of scorpions feed in the same manner. The prey is grasped by the pincers, stung, and then ripped apart by the chelicerae. The viscera of the victim is bathed in a clear, colorless fluid exuded from the scorpion's mouth. While this is being exuded, the front legs are drawn backward and forward in a horizontal plane. This motion is also seen when the animals drink or engage in "sponge bathing." It would appear to be related to the movement of the sucking pharynx.

A. phaeodactylus seldom uses its sting for capturing prey and rarely uses it while eating. *V. sylvestrii* often stings its prey and may keep the sting embedded in the victim as the latter is eaten. Often the animal being devoured remains alive throughout the meal and may be released to crawl away even after part of its body has been eaten. This is evidence that these scorpions' poison is not highly virulent.

Only *V. sylvestrii* has been observed drinking. To drink, the scorpion touches its chelicerae to the water and moves its legs in the manner previously described for eating.

Scorpions are hardy animals and may survive long periods without food. One specimen of *V. sylvestrii*, though given only water, survived eight months.

Exploratory Behavior

When introduced into a soil filled cage, a scorpion shows a pattern of cautious exploration. It begins by following the walls of the enclosure around its periphery. Constantly waving its pedipalps above and before it, the scorpion may traverse this loop up to 50 times, often reversing direction. The animal then breaks out of this orbit and ventures diagonally toward the center of the cage floor. It will return to the wall path before again turning toward the cage center. Eventually the scorpion will cover the entire area. However, regardless of the amount of territory investigated, the scorpion will return to its original path where it will spend most of its time.

After investigating their surroundings, burrowing scorpions usually dig a shelter. They then divide their time between walking around their cage and remaining in the burrow.

The errant types of scorpions will constantly attempt to escape by climbing the walls of their enclosure. They balance precariously on their extended cauda and claw for a foothold with their pedipalps and legs.

When introduced into a glass cage scorpions spend little time in exploration. Instead, they will direct most of their efforts toward climbing up and out of the container. When placed in a cage with an inclined floor, scorpions generally attempt to escape up the incline.

These ambulatory activities have been observed during all hours of the day and night, but they occur most frequently at night.

Sensitivity to Air Currents

Scorpions are able to detect intruders and locate prey by sensing slight currents of air. An instance has been observed of *A. phaeodactylus* locating and capturing an ant that was completely hidden. In a confined space *A. phaeodactylus* is also able to detect and capture flying moths.

The pedipalps are especially sensitive. When scorpions are first aware of an air disturbance they will often turn their pedipalps toward the source. *A. phaeodactylus* spreads its pedipalps in an arc in front of its body as it waits for prey at the mouth of its burrow. Even though it is hidden within its burrow it is able to detect the approach of an insect.

Hoffman (1966) suggests that the trichobothria serve as mechanoreceptors for airborne vibrations. The sensitivity of the pedipalps where large numbers of these special hairs occur supports his conclusions.

When air puffs from a micro-pipette strike a scorpion it is quickly aroused. The position assumed is described by Millot and Vachon (1947) and by Babu and Palka (1967) as a defensive position. Perhaps it would be better described simply as a strike position. It is often observed when the scorpion is not defending itself, but only attacks its prey.

The behavior associated with this strike position consists of turning toward the disturbance, raising the cauda in an arc over the body while extending the legs, raising the body high above the ground, and spreading the pedipalps with the chelae open wide.

If air puffs are again directed in front of, or upon, the pedipalps, the scorpion may flee but is usually provoked enough to strike out.

This pattern has been observed using *A. phaeodactylus*, *V. sylvestrii*, and *V. mordax*. Palka and Babu report similar results using seven species of Indian scorpions.

Death Attitudes

When scorpions die they assume one of two postures. One position is often seen when a scorpion is subjected to trauma. Bringing the animal out of its burrow on a hot summer day will cause it to lose equilibrium, arch its back and cauda, curl its legs under its body and fall to the side.

The other position is identical with the scorpion's resting position. The body is held close to the ground with the legs slightly drawn in. The pedipalps are also retracted and the cauda is either arched above the body or extended straight back and resting on the ground. Often scorpions with no apparent disease or injury will be found dead in this position.

Cohabitation

Burrowing scorpions are generally regarded as solitary animals, intolerant of any intruder. This is not always the case. *A. phaeodactylus* does not always behave in this manner. An instance of cohabitation was noted in the laboratory and one case was observed in the field. In both cases the scorpions were of the opposite sex and the male was mature.

In the laboratory the scorpions were kept in an 8″ × 10″ × 14″ terrarium which was filled to a depth of eight inches with closely packed soil. No aggressive behavior or mating was observed. The scorpions often wedged themselves into the same burrow and both devoured beetles given to them. This pair lived together 26 days until the male died.

Also, a pair of scorpions was discovered inhabitating the same burrow in an *A. phaeodactylus* colony. The female occupied a terminal chamber while the male was in an antechamber about twelve inches from the burrow's entrance. The burrow was about fifteen inches long and extended to a depth of eight inches.

These two examples are evidence that scorpions may remain together for periods longer than are necessary for mating.

Anuroctonus Colony

The burrows of *A. phaeodactylus* are found in dense aggregates as well as singly. Two colonies are known in the San Diego area. Williams (1963) discovered an area near the Barona Indian reservation at Lakeside. An extensive colony is also located on Kearny Mesa near the Miramar Naval Air station.

Williams reports that the burrows are found most abundantly in burned-over areas, on sloping sedimentary hillsides with south-eastern exposures and are rarely found on level ground. However, I have found that at the Miramar colony the burrows are less frequent in areas previously burned. All the burrows were found in level ground and they open to face in all directions.

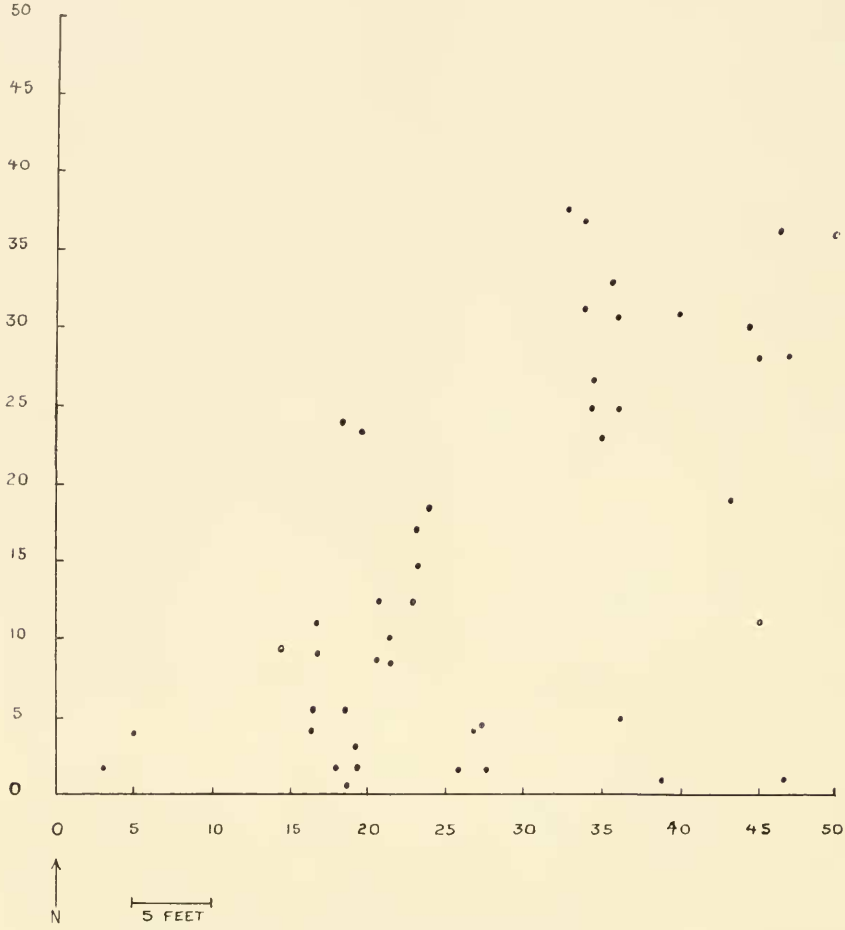

Fig. 1 (below) is a map of a level, 2,500 square foot a ea of the Miramar colony. This shows the situation as of October 29, 1967. 46 scorpions were found within the boundaries of the area. This is a density of about one scorpion for 50 square feet. However, as the illustration shows, the scorpions were not distributed evenly throughout the area but occupied only about one-half of it. In another sector of the colony the density may be much higher.

The Miramar colony is located on a dry, chapparal-covered flat. The soil is sedimentary and of a dark reddish hue. This soil was analyzed for particle size composition, per cent organic matter and maximum water retention capacity. Samples were taken at the ground surface and at a depth one foot below ground level. Particle size was analyzed by the Buoyocous hydrometer technique and found to be the same at both levels. The soil was found to consist of 38.2% sand; 36.3% new silt; 32.4% old silt; 25.4% new clay; and 29.0% old clay.

The organic content was determined by weighing a dried sample of soil, igniting it at 500° C for one hour and then reweighing it. The loss was considered to be the weight of organic material present in the soil. This amounted to 8.0% of the surface soil and 6.3% at a one foot depth.

Water retention values were obtained by soaking a previously dried and weighed sample in distilled water for one hour, allowing it to drain for fifteen minutes and then reweighing it. Any increase in sample weight was considered to be due to water remaining in the soil. The soil had a high moisture capacity of 0.629 grams H_2O/1.0 gram soil at the surface and 0.551 grams H_2O/1.00 gram soil at the one foot level. High moisture retention by the soil may be due in part to the high proportion of silt and organic matter present.

At Kearny Mesa the total annual rainfall is about eleven inches, but only trace amounts are recorded in the months from May to September. The construction of a burrow by *A. phaeodactylus* is a favorable behavioral adaptation for this climate. Water trapped in the soil provides the retreat with an atmosphere that is more moist than the outside air. The moist soil also serves as an insulative layer during temperature extremes.

The individual scorpion's burrow is unique in its construction. The mouth of the burrow, depending on the size of the animal, is about one-half to one inch in width, flat at the base and rounded above. A single burrow may have two openings as close as one inch apart. The opening, difficult to detect from behind, is only seen easily when viewed directly from the front. The tunnel opens into a shallow pit trap about one inch in diameter which is immediately outside the burrow mouth and into which the scorpion may extend about one fourth to one half its body length.

The burrow descends at an angle of 20 to 45 degrees for four or five inches. At this point it may curve to the right or left or double back. The tunnel does not ascend again at any point. The burrow twists in this fashion until it is about seven to twelve inches underground. The tunnels are often lined with vegetation at a distance of about five inches from the mouth.

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The Entomologist's Record

To encourage the publication of concise and useful new distribution records, corrections of previously published erroneous records, misidentifications, short field notes, and current news items about entomologists, amateur and professional, entomology departments and museums, prompt (monthly) publication is offered in this department.

[See also p. 268.]

John Wagener Green (September 25, 1889—June 20, 1968): Wagener Green, who passed away on June 20, was the North American authority on the beetles of the family Lampyridae, the fireflies, and on several related families. Most of his life was spent at Easton, Pennsylvania. After taking a degree in engineering at Lafayette College (1908), and a course in Agriculture at Cornell University, he became the manager of the extensive Wagener family orchards, with major acreage in peaches. His hobby was the study of beetles, of which he had one of the largest private collections in the country. In 1911 he was invited to join Mr. H. A. Wenzel in an expedition to Texas; they hired a man with a team and wagon, and traveled across country in the Chisos mountains and other parts a little north of the Panhandle. Specimens taken then provided material for his earliest technical papers, the first of which appeared in 1917. His last, of over 60 pages with many illustrations, was published in 1966. Upon his retirement Mr. Green visited the California Academy of Sciences in early 1949, and began his work as a skilled preparator of insects in November of that year. Later he returned to Easton to settle his affairs, and to get his collection of 84,000 beetles, which was added to the Academy's collections in 1952. During his time there, he painstakingly mounted hundreds of thousands of specimens, and the Department of Entomology has received compliments on his work from research workers in many countries. Wagener Green was always cheerful, and ever willing to help others. Universities as well as private collectors across the country sent their fireflies and related beetles for identification; this work, as well as his research on the beetles, he did in his spare time. Quiet, and retiring, a skilled and fast worker, he regularly put in an hour or more of overtime a day for the Academy, until stopped by illness in September, 1967. His published articles and large collection assure him a place in science; his personality, kindly, humorous, steadfast, will ever be remembered by his friends. He is survived by his wife, Mrs. Katherine O. Green, a son, a married daughter, and several grandchildren, to whom our sympathies are extended. —HUGH B. LEECH, *California Academy of Sciences*.